

AIRCRAFT CIRCULARS
NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

No. 206

ARMSTRONG WHITWORTH 27 "ENSIGN" COMMERCIAL AIRPLANE (BRITISH)
An All-Metal High-Wing Monoplane

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An All-Metal High-Wing Monoplane

The new Armstrong Whitworth monoplane (figs. 1, 2, and 3), of which twelve have been ordered by Imperial Airways, is an all-metal, high-wing monoplane with a landing gear, the halves of which retract into the inner pair of the four wing-mounted engine nacelles.

The wing structure consists of a single large box spar of light-metal construction to which are attached the front and rear portions of the wing ribs (figs. 4, 5, 6, and 7). The wing construction forms, in fact, an intermediate stage between the stressed-skin multispar type and what is called the "concentrated flanges" type. It also affords an interesting comparison with the type of construction employed in the Short "Empire" flying boats.

Extruded T-sections are employed at the spar corners tying them together with fork-ended tubes which form a girder, using Z-sections at the corners and connecting them with light-metal panels of corrugated form. The rectangular section box thus formed is stabilized by tubes forming diamond-shaped trusses inside the box.

The resultant wing spar is not only a good beam for taking bending stresses, but the stabilized box is excellent for resisting torsion loads. It is assisted in this by the sheet-metal covering over the front portion. The trailing-edge portion of the wing, on the other hand, would in any case be rather too shallow to form an efficient structure member, and so fabric covering is used over this portion, the method of attaching the edge of the fabric being shown in figure 4.

An examination of the sketches will reveal at once to the aircraft engineer the reason for the use of Z-sections in the spar corners: the edges to be riveted are readily accessible and there are no awkward corners into which the dolly cannot be inserted. Automatic servo flaps are inset into the trailing edge of each of the mass-balanced Frise

*From Flight, January 7, and April 1, 1937.

ailers, that on the port side being under the control of the pilot for lateral trimming purposes. Split trailing-edge flaps, actuated by four Lockheed hydraulic jacks, extend between the ailerons and fuselage.

The high-wing arrangement offers not only aerodynamic advantages, but is a godsend to passengers, who might otherwise have to endeavor to crane their necks to view scenery past the trailing or leading edge of a low wing. Typically practical, Imperial Airways claim that the high wing also has the advantage of sheltering passengers entering or leaving the airplane from sun or rain.

FUSELAGE FEATURES

The fuselage - an oval monocoque structure 110 feet long - is more or less conventional in conception, incorporating transverse frames, longitudinal stringers, and sheet-metal covering (figs. 8, 9, and 10). A section is suitably recessed to receive the wing and in this region embodies a massive structure to take the flying stresses (figs. 11 and 12). A substantial system of tubular girders is built into the lower portion of the fuselage beneath the floor.

The student of modern design will doubtless be struck by the fact that, as on the "Empire" flying boats, a single fin-and-rudder assembly is employed, whereas the general tendency abroad is to duplicate this structure. The length of the fuselage and ample fin and rudder area should result in good directional qualities.

Structurally the tail unit is of the monoplane type, being built up in a similar manner to the wing (fig. 13). Fore-and-aft trim is maintained by tabs in the elevator which, incidentally, is not aerodynamically balanced but has a spring-loaded balancing device incorporated in the internal controls. A servo flap, which is also arranged to function as a trimmer, extends over the entire trailing edge of the rudder. Like the fin, this member is fabric-covered.

Since each of the two "Ensign" types has been designed to the order of a single operating company, it might be expected that the accommodation and interior equipment would bear some resemblance to those of the Short "Empire" flying

boat. This resemblance is, however, superficial, for the airplanes have been developed for somewhat different purposes.

As in the case of the flying boat, the big Armstrong Whitworth has its passenger quarters arranged so that either chairs or bunks may be fitted (figs. 14 and 15), and it is interesting to learn that the change-over in the long-distance or "Empire" class can be made in a matter of a quarter of an hour. Twenty-seven seats are removed and are replaced by twenty bunks, with partitions, curtains, and all the necessary equipment for sleeper comfort.

On through services, when an airplane is flying by day and night, the change-over would probably be made while the passengers were eating their dinner at the airport hotel or rest house. The bunks are arranged in tiers of two; those using the lower ones will have the normal cabin windows at their level, while those in the upper berths have small auxiliary windows which normally serve to increase the amount of light in the upper parts of the exceptionally deep cabins.

An interesting aspect of the method of making the day-to-night change-over is the fact that the seats and backs of the daytime chairs are transferred to the bunks and form part of the mattresses. This somewhat peculiar transfer is necessary because these parts of the chair are designed to act as the life savers which are a legal necessity for any sea-crossing service. The chairs are entirely similar to those developed for the "Empire" flying boats, which are the result of some two years of test and experiment and are made at Imperial Airways' own furniture factory at Wandsworth.

There are three passenger compartments in the "Ensign," and each of these has its own emergency exit in the form of a sliding panel in the roof. Figures 15 and 16 clearly show the general lay-out. The first compartment lies directly behind the control cabin, while the other two are toward the rear of the fuselage. All of them, of course, are well away from the plane of the propellers and from the vicinity of the main spar, which carries the power units. Furthermore, the corrugations in the bulkheads and so forth should prevent any sign of drumming. The cabins should, consequently, be very quiet even without the addition of the soundproofing equipment which one might expect to see.

Behind the forward passenger compartment is a large freight hold (which can be loaded from the outside through two wide doors), a pantry, a mail department, and a lavatory. Beside these compartments, on the port side, is a feature which appears to be very popular with passengers on the "Empire" flying boats - the promenade deck. Both here and in the front compartment, smoking will be permitted. In the upper part of the fuselage, above the promenade deck area, is a space for normal luggage. The main entrance for the passengers is on the promenade deck and there is another at the rear of the cabin - where, also, there is a lavatory and a second freight compartment with a sliding door. The interior of the tail may be reached, for purposes of inspection, through the rearmost bulkhead.

Apart from the normal fresh-air ventilators, which can be adjusted by each passenger, an exhaust-heated ventilation system is under the control of the steward. This system is described elsewhere.

In the European class of A.W. 27, forty-two passengers are carried. Obviously, it would not be possible to accommodate them all in the three main compartments, and in the case of this type the forward freight compartment becomes a "cardroom," where four passengers are comfortably ensconced. In addition, there are twelve seats in the forward cabin and twelve and fourteen, respectively, in the two rear compartments.

The cabin windows are of Perspex made up by the Triplex Company, the pilots' windows are of Splintex safety glass, and various inspection panels are covered with Rhodoid.

Generally speaking, the instrument lay-out is similar to that in the Short flying boats (fig. 17) - not unnaturally, since this lay-out was the subject of a very great deal of thought and because the flying-boat pilots may occasionally be expected to take over these landplanes at short notice. In the center of the instrument board is the Sperry automatic-pilot panel, while above this are the engine switches and a master switch controlling the landing gear and flap indicators. Until this master switch is moved to the "on" position, the engine switches themselves are inoperative and the captain, therefore, cannot possibly take off without first checking the positions of the flaps and landing gear. Above the screen, in the center, are the four engine-starter and two windshield-wiper switches.

On the left of the Sperry panel are all the essential navigational instruments, including the usual Sperry horizon and gyro, a sensitive altimeter, a rate-of-climb indicator, and so forth. Beside the captain, on his left, are levers controlling the oil relief valve (permitting a heavy circulation of oil during the warming-up process) and the slow-running cut-outs for the four Tiger engines. Farther aft on the same side are the fuel-tap controls.

The central throttle bank column carries, in addition to and alongside the four throttle levers, the variable-pitch propeller control on the left, and the mixture control on the right. Ahead of the gates, on either side of the column, there are two other levers; that on the left controls the valves for the landing gear retraction pumps, and that on the right controls the flap-operation valves. The pilot has merely to move one or other of the levers into its new position and the engine-driven pumps do the rest.

On the face of this central column is a small lever which can be moved up, down, or sideways. This little affair controls the entire Dunlop pneumatic braking system. Movement in the fore-and-aft plane applies or releases the brakes, while sideways movement brings the differential operation into play for maneuvering on the ground. On the left of the column and at the level of the brake control lever is the usual Sperry pilot cut-out lever.

A useful feature which is not often to be seen on British transport airplanes is a direct-reading driftsight, which is arranged on the floor of the cabin between the two pilots. Each pilot, of course, has his own compass.

The "Ensign" type cannot only be trimmed in the fore-and-aft and directional planes, but has tabs on each of the ailerons, so that any slight lateral trim differences may be corrected while in flight. This aileron trimming wheel is mounted on the roof above the chief pilot's seat, while the elevator and rudder trimming wheels lie, one behind the other, on the right-hand side of his seat, so that they may be reached by either pilot. An interesting comfort detail concerns the first officer's chair, which not only slides backward and forward, but also swivels in order to simplify movements in and about the cabin. Entrance is normally effected through a trap door in the floor behind the "bridge," though there is, of course, a door leading to the front compartment. An emergency exit is provided.

Behind the pilot's platform is the radio operator, who sits facing starboard, on which side are his Marconi transmitters and receivers. In the case of the European type these will have the normal medium-wave tuning range, while the "Empire" class will, in addition, have short-wave equipment.

Additionally, D/F equipment is installed; this may be used either for obtaining direct bearings or, with the loop in a fixed position, for "homing." An indicator lies in front of the captain, immediately below his more important navigational instruments. The loop is not of the retractable type.

On the port side of the operator's compartment is a small fuel motor, similar to that used in the "Empire" flying-boat equipment, which is permanently coupled to a generator. Thus, in case of a long wait on the ground with, perhaps, the radio and lighting in action, the main battery system may be replenished without the necessity of running one or other of the engines which, through their generators, normally keep the battery up to scratch. A Rotax switchboard, covering the domestic electrical equipment of the airplane, is in charge of the steward. The following Rotax equipment is specified: Two 24-volt, 1,000-watt engine-driven generators with two voltage control boxes; cabin lamps; roof lamps; navigation lights; switches and fuse boxes.

Power is supplied by four Siddeley Tiger IX geared and moderately supercharged radials, which are carried on welded tubular structures forward of the leading edge, these being provided with Armstrong Siddeley patented flexible rubber mountings.

The Siddeley Tiger IX is a recently introduced engine developed from the Tiger VI, as used in large quantities by the Royal Air Force. The engines for the "Ensigns" will be standard units except for certain drives introduced specially for service with Imperial Airways.

Rated at 790 horsepower at 2,375 r.p.m. at 6,500 feet, the Tiger will deliver 810 horsepower maximum at 2,450 r.p.m. at 6,400 feet. With the three-blade De Havilland two-position variable-pitch propellers set at fine pitch, 880 horsepower is available for take-off at 2,375 r.p.m., the automatic boost control then being overridden.

TWO-ROW ENGINES

The engine has fourteen cylinders, arranged in two staggered rows, the capacity being 1,996 cubic inches, and measures 50.8 inches in diameter.

The engines are enclosed in standard Siddeley long-chord cowling rings, which have inner and outer sections for the purposes, respectively, of directing the air flow around the cylinders and giving an aerodynamically efficient exterior.

Gasoline and oil tanks with respective total capacities of 670 gallons and 40 gallons, are mounted in the leading edge.

A boiler on the exhaust pipe of one of the inboard engines supplies steam to a heater box. Cold air is blown through this box, warmed, and delivered to the cabin, the supply being regulated by the steward. A system of branch pipes supplies cold air.

The A.W. 27 has the largest retractable landing gear developed to date, the entire mechanism for raising and lowering being of Lockheed production. Each of the two independent units is located under each of the engine nacelles, which are of considerably larger dimensions than their outboard neighbors. The Dunlop wheels stand over 6 feet 3 inches high and are about 27 inches wide. The retracting movement is rearward and upward into the fairings behind the main spar, a portion of each wheel being left protruding below each nacelle when the gear is completely raised. Doors are provided to preserve a smooth contour when the landing gear is up, these being interconnected with the retracting mechanism. A special valve allows the fluid controlling these doors to be jettisoned in an emergency without the loss of fluid in the other systems.

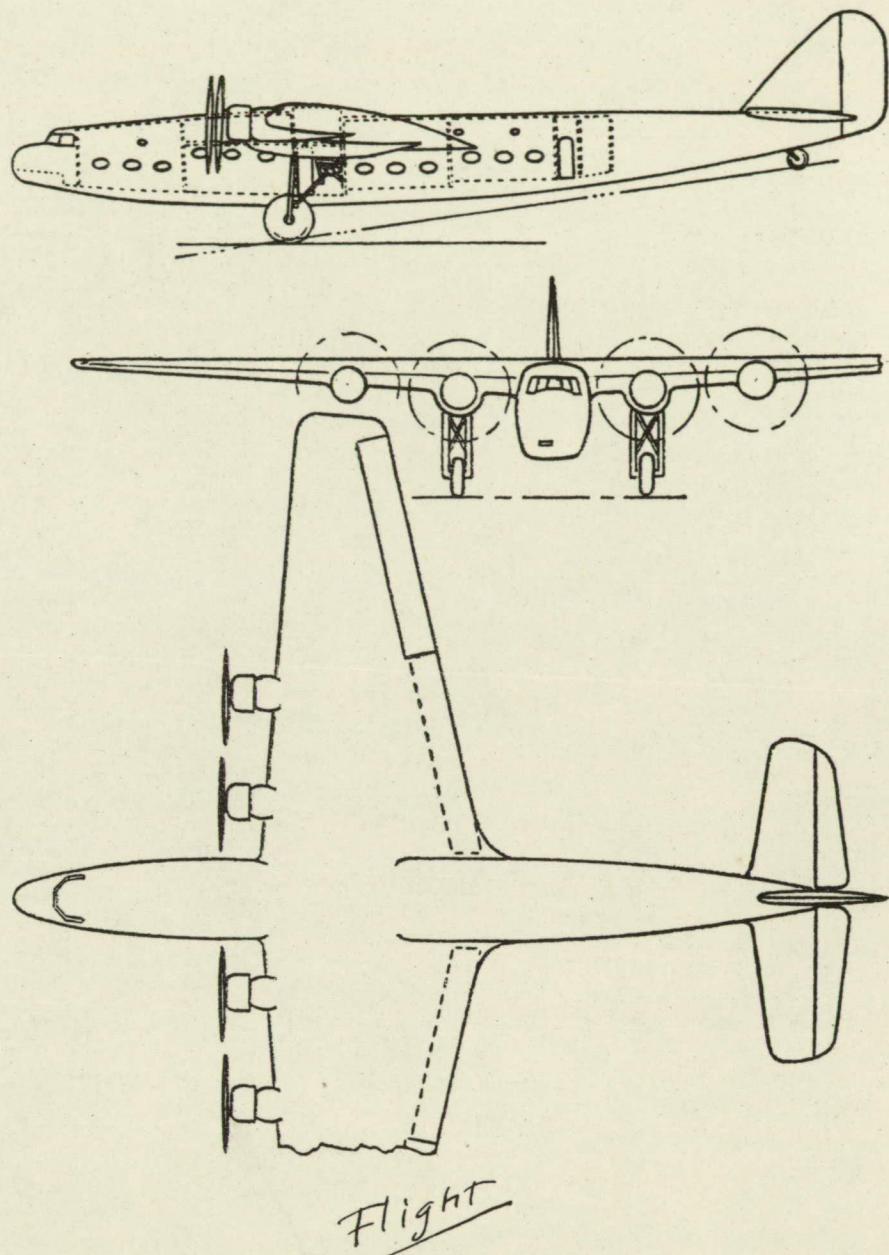
Lockheeds were faced with some problems in developing gear to operate the flaps, landing gear, and wheel doors. In all, there are sixteen jacks - four for retracting and lowering the landing gear, four for the flaps, four for the wheel doors, and four to lock the landing gear in the raised position. The fluid system has three engine-driven pumps. The pilot is provided with the new Lockheed selector valves which return the operating levers to neutral when an operation is completed.

The landing-gear jacks (fig. 18) are 3-1/2 inches in diameter, and should raise the wheels in 1-1/4 minutes and lower them in 50 seconds.

OVER 200 MILES PER HOUR

Complete estimated performance figures for the A.W. 27 are not available, but the top speed should exceed 200 miles per hour, and the economical cruising speed is expected to be about 160 miles per hour, although, undoubtedly, the airplanes could be continuously operated quite safely at a higher speed. Fully laden they will weigh rather more than 20 tons and should be able to maintain height at 12,500 feet, using only three of their four Tiger engines, and at 4,000 feet on two engines.

The normal range will be 500 miles against a 40-mile per hour head wind, but with extra tankage and reduced pay load, this can be increased to 1,000 miles under the same conditions.

*Flight*

Span, 123 ft.
Length, 110 ft.
Height, 23 ft.

Wing area = 2450 Sq.ft.
Tail plane area = 402 Sq.ft.
Fin & rudder area = 173 Sq.ft.

Figure I.- General arrangement drawing of the A.W. 27 airplane.

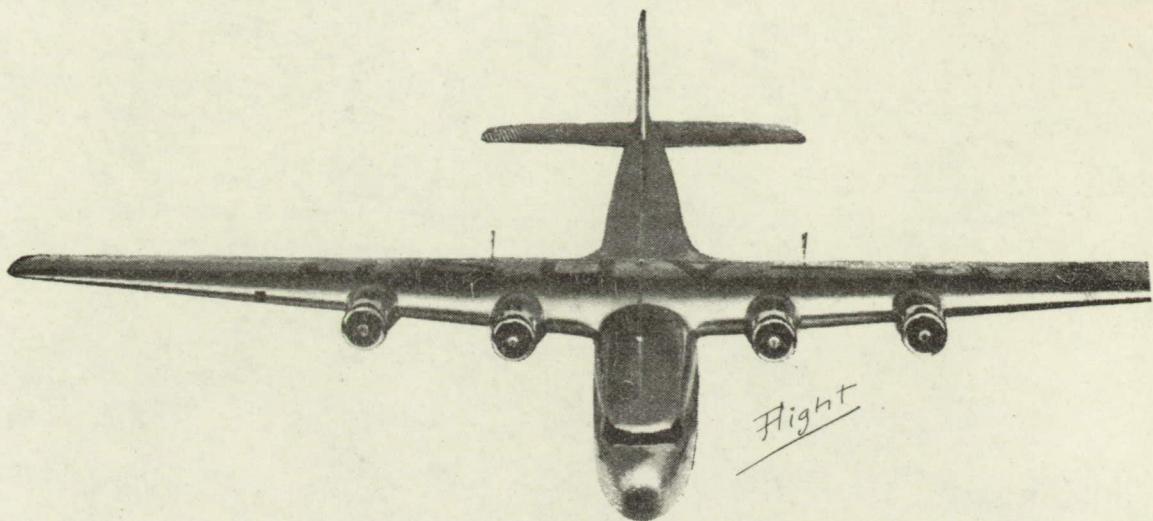


Figure 2.- The A.W. 27 in flight.

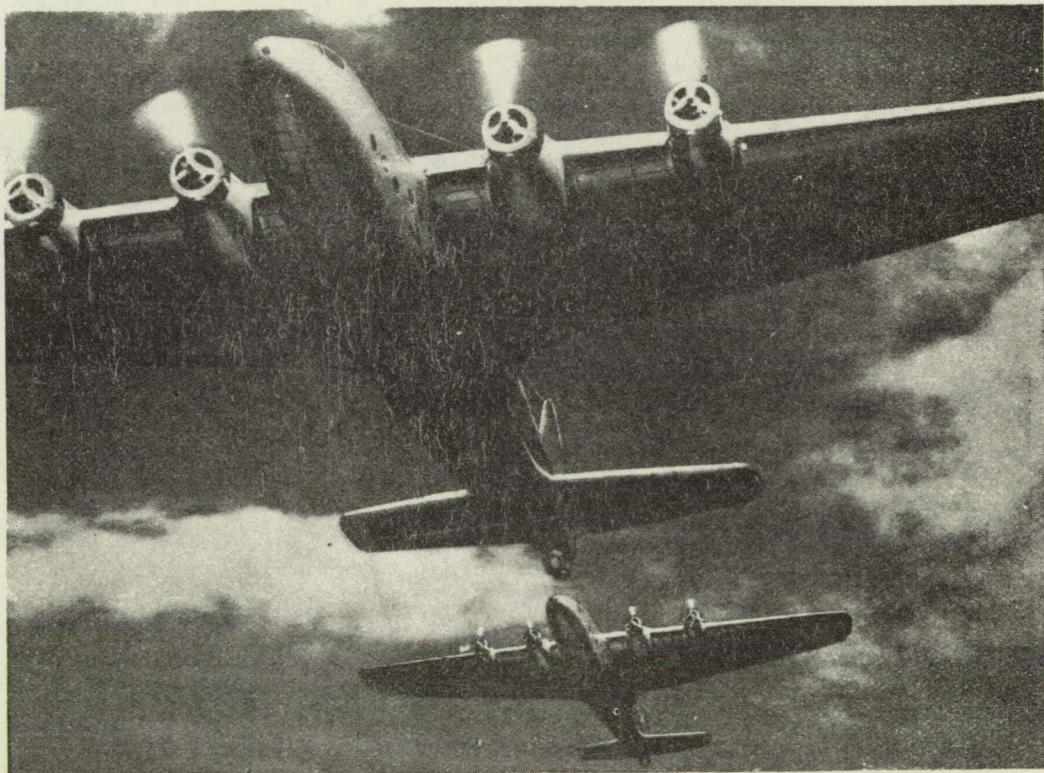


Figure 3.- Weighing nearly 20 tons, the A.W. 27, or ensign class, will carry 40 passengers on the European routes and up to 27 passengers on Empire routes.

Flight

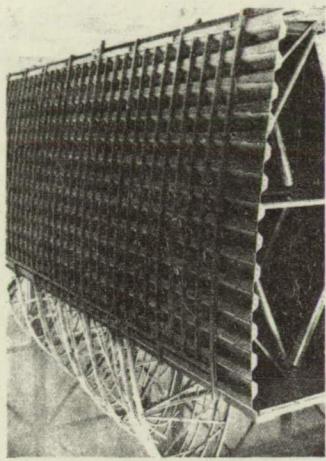


Figure 7.—One of the wings of the Ensign, in which corrugated metal sheeting forms the upper and lower sides of the single box spar. Only the leading edge formers are in place in this view.

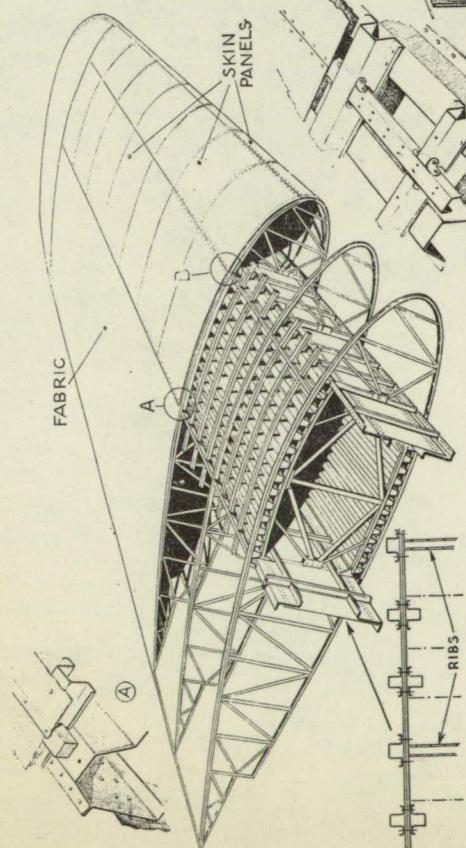


Figure 4.—The wing construction of the A.W.27 incorporates a single box spar and the covering is partly light metal and partly fabric. The sketches show how these materials are attached to the wing framework.

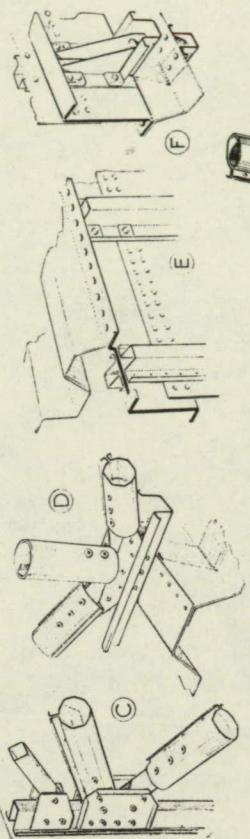


Figure 5.

Figures 5 and 6.—Details of the wing spar and rib construction.

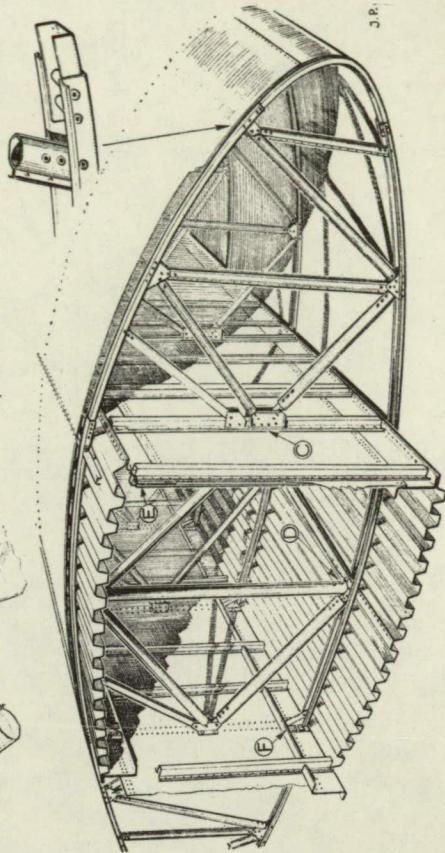


Figure 6.



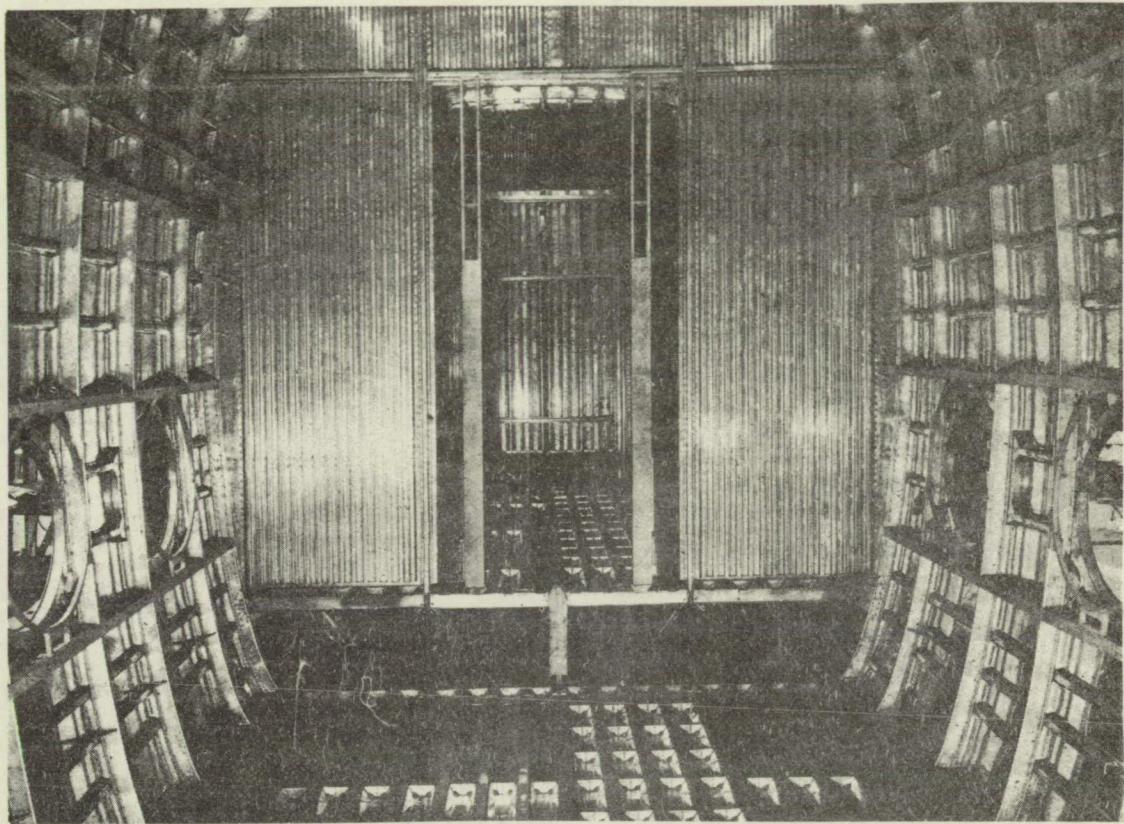


Figure 8.- Inside the fuselage. The longitudinal stringers are continuous and are joggled into the frames. The floor beam supports take the form of girders of tubular construction.

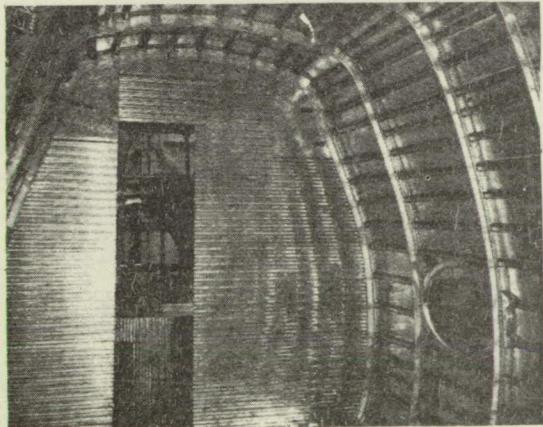


Figure 9.- A view inside the forward cabin looking towards the pilot's cockpit.

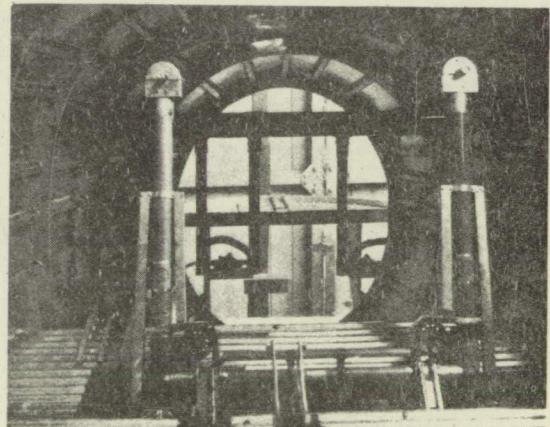


Figure 10.- The "Office": Note the two control columns, ready for their wheels, and the hanging rudder pedals. The tail trimming wheel is seen in the center, at floor level.

Flight

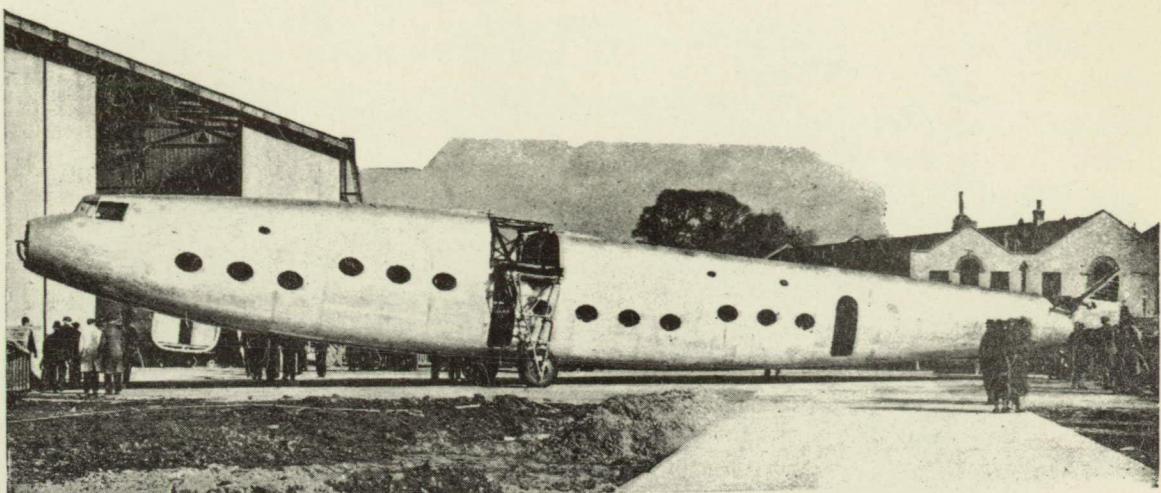


Figure 11.-This view of the first A.W.27 fuselage gives a vivid idea of its immense size. The overall length is 110 ft.

Flight

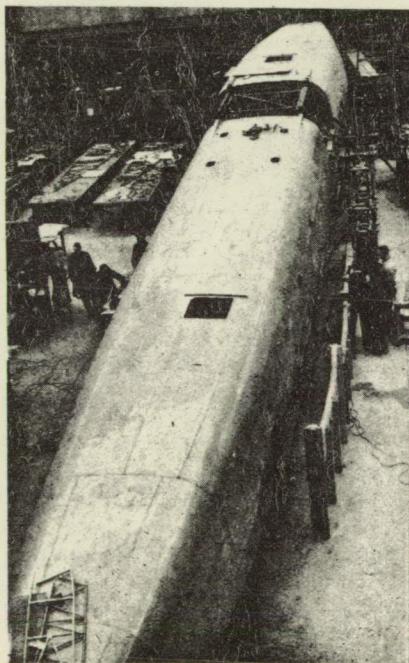


Figure 12.-The Ensilage: Another view, taken in the shops, which gives an excellent idea of the massive proportions of the stressed skin body.

Flight

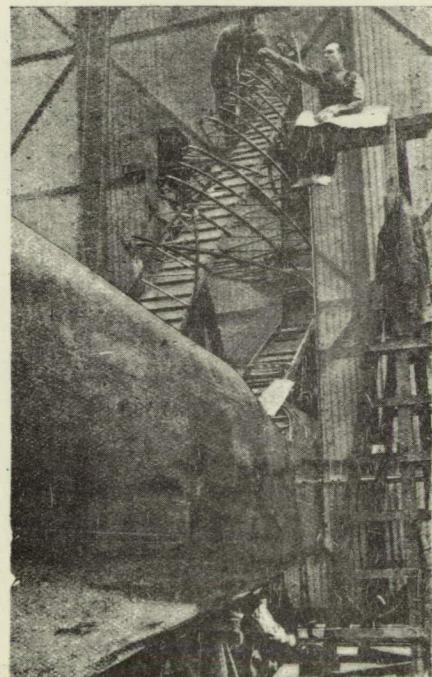


Figure 13.-The after end; the fin skeleton.

Flight

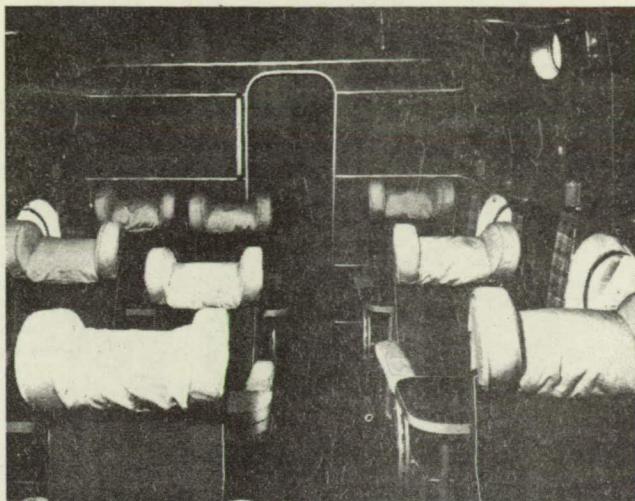


Figure 14.- The passengers seats in each cabin are of Imperial Airways own design, and are instantly adjustable to any angle required by the user. This view is in the "mock up" for the Empire-type Ensign. *Flight*

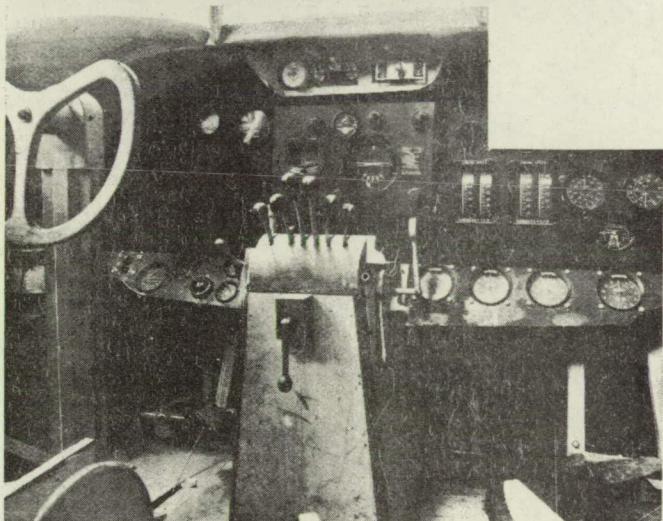


Figure 17.- Some idea of the instrument and control layout can be gathered from this photograph. On the throttle column can be seen the brake, flap, landing gear, automatic pilot and v.p. propeller controls. In the center is the Sperry panel, while on the left can be seen the essential navigational instruments. *Flight*

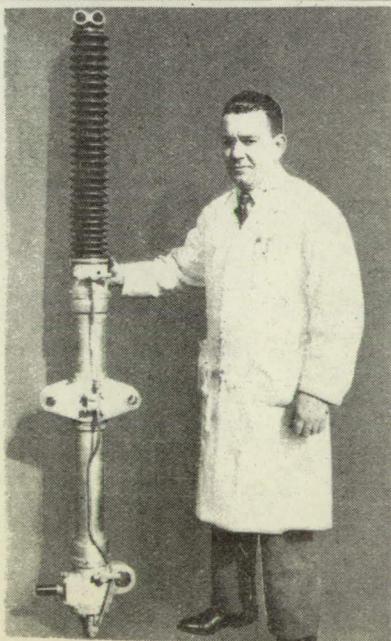


Figure 18.- Literally "man size", the Lockheed hydraulic landing gear jacks, of which there are 4, measure 54" in. in their closed position and 84" in. extended. *Flight*

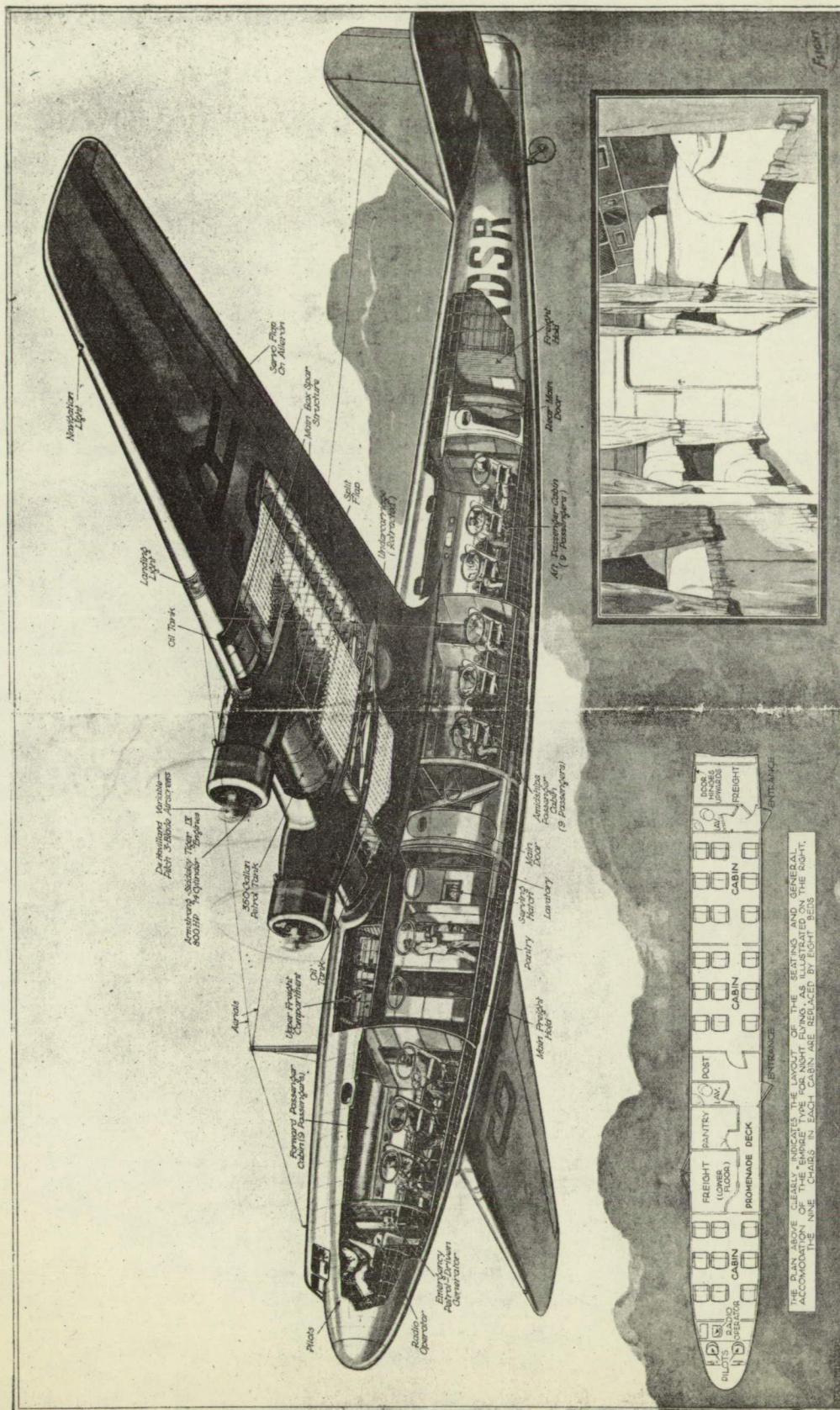


Figure 15.—The A.W. 27 is the most advanced heavy transport landplane (in the stage and nature of its construction and in the degree of comfort and safety it affords its passengers) yet ordered by an airline. Powered with four Armstrong Siddeley Tiger IX fourteen cylinder moderately supercharged and geared radial engines; its estimated maximum speed exceeds 200 m.p.h.; the normal cruising speed being about 160 m.p.h. The total weight is over 20 tons.

THE ARMSTRONG WHITWORTH ENSIGN

(Four 800 h.p. Armstrong Siddeley Tiger IX Motors)

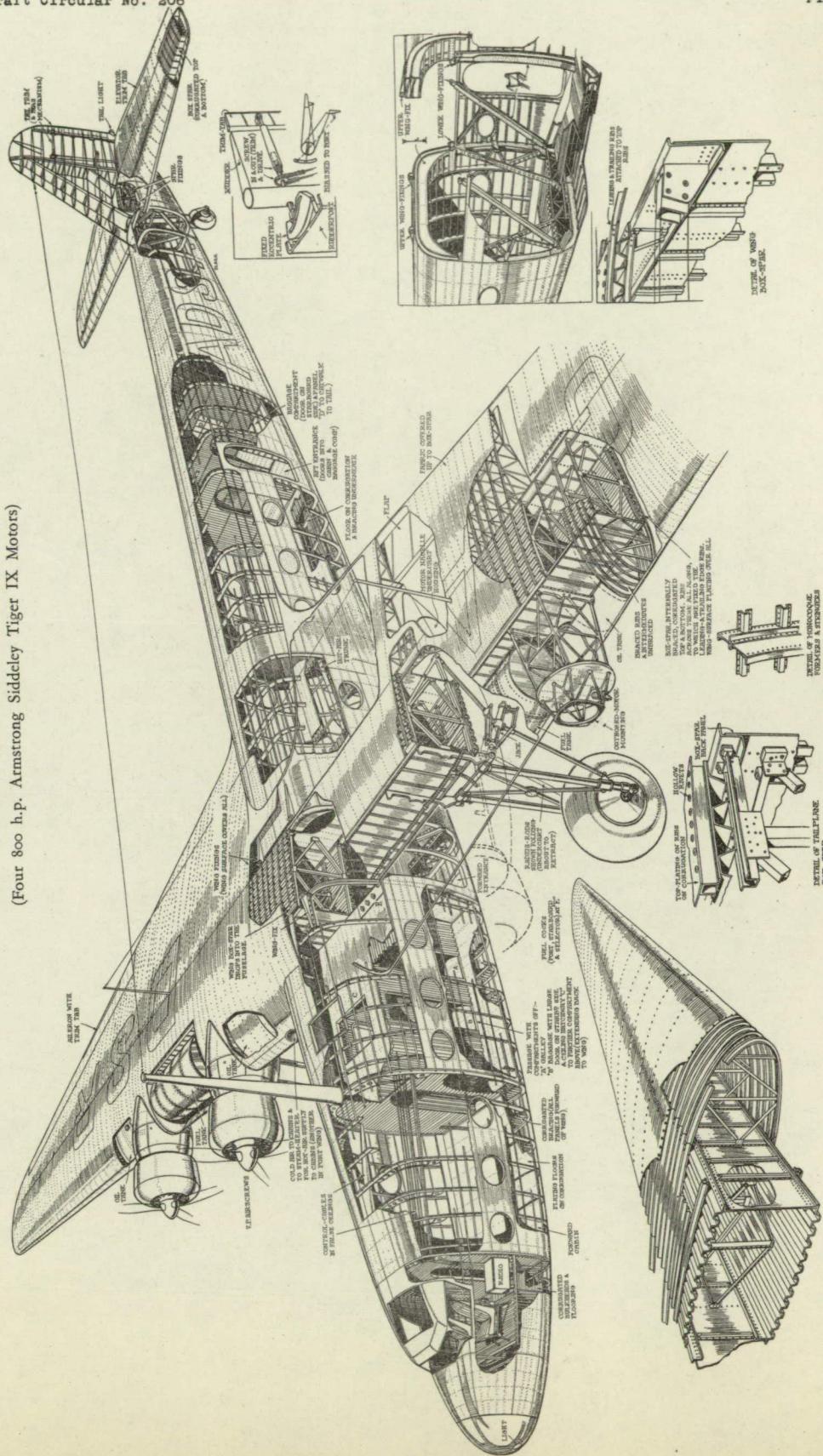


Figure 16.